PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 85/TY00M06/WO	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. PCT/IB2004/002317	International filing date *(day/month/year)* 19.07.2004	Priority date *(day/month/year)* 22.07.2003
International Patent Classification (IPC) or national classification and IPC H01M8/24, H01M8/02		
Applicant TOYOTA JIDOSHA KABUSHIKI KAISHA et al.		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 6 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 7 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the opinion
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☒	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
20.05.2005	08.11.2005
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Jacquinot, P Telephone No. +49 89 2399-7239

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/IB2004/002317

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3 and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4)
   - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1, 3-21	as originally filed
2, 2a, 2b	received on 20.05.2005 with letter of 19.05.2005

Claims, Numbers

1-23	received on 20.05.2005 with letter of 19.05.2005

Drawings, Sheets

1/26-26/26	as originally filed

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	10,11,15,17,21
	No:	Claims	1-9,12-14,16,18-20,22,23
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-23
Industrial applicability (IA)	Yes:	Claims	1-23
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item V

1. Considered documents

The following documents (D) are referred to in this communication; the numbering will be adhered to in the rest of the procedure:

D1: PATENT ABSTRACTS OF JAPAN vol. 1997, no. 08, 29 August 1997 (1997-08-29) & JP 09 092324 A (TOYOTA MOTOR CORP), 4 April 1997 (1997-04-04)
D2: DE 100 49 801 A (TOYOTA MOTOR CO LTD) 26 April 2001 (2001-04-26)
D3: DE 196 45 111 A (AEG ENERGIETECHNIK GMBH) 7 May 1998 (1998-05-07)
D4: US-A-4 176 213 (VAN LINDEN JACQUES) 27 November 1979 (1979-11-27)
D5: US-A-5 824 199 (NEWMAN JOHN SCOTT ET AL) 20 October 1998 (1998-10-20)

2. Novelty

The subject-matter of claims 1-9, 12, 13, 14, 16 and 18-20, 22 and 23 appears not to satisfy the requirements of novelty according to Article 33(2) PCT:

2.1 **D1**(JP 09092324) discloses in Figures 1-6 a fuel cell assembly (10) being composed of a plurality of stacked multi-cell modules (30) each having a module frame (31) clamping a plurality of single unit cells together (e.g. four unit cells (45) as can be drawn from Figure 4), the stacked modules all being surrounded by an external enclosure (20). An (elastic) insulation layer (29, 39) made from rubber or a resin is provided between multi-cell modules (30) and inner wall of frame (31) (see Fig. 4) as well as between outer wall of frame (31) and the enclosure (20) (see paragraphs [0034] and [0037]). This insulation layer provides the functionality of an external restraining member. A cooling plate (50) is arranged at one end of each multi-cell module (30) and it contacts the (electrically conducting) separator plate (70) of an adjacent module. The module frame can also consist of at least two frame members (440) as can be seen in Figure 19. The subject-matter of **claims 1-4 , 6-9, 12, 13, 16 and 18-20, 22 and 23** is not novel.

2.2 **D2**(DE 10049801) discloses in Figures 1 and 13-20 fuel cell modules (100) secured in the stack axis by a elastic holding plate (170) coated with an insulating material (174) for

electrically insulating the cells from the plate. A spring (220) applies a uniform pressure on the stack. Several of these modules are enclosed within a container (2, 3) for the sake of protection. Coolant plates (140) are arranged within a stack. In contrast to the present application, an external restraining member provided between an inner face of the external container and the external face of the multi-cell modules can not be derived from D2.

2.3 **D3** (DE 19645111) discloses in Figures 1 and 2 a fuel cell apparatus comprising a plurality of multi-cell modules surrounded by elastic, electrically insulating frames (8), the modules being housed in an enclosure (13) also having an insulating layer (12). Said insulating layer is regarded as external restraining member. Said frames have grooves for providing a gas passage between the modules. Springs (14) provide a uniform compressing force. The insulating materials are explicitly elastic and allow gliding of the stack due to thermal dilatation (see column 2, lines 7-32). An intermediate layer (21) provides electrical contact between modules. The subject-matter of **claims 1, 2, 4-6, 9, 13, 14, 16, 18 and 19** is lacking novelty.

2.4 **D4**(US 4176213) discloses in Figure 1 a fuel cell system comprising at least two multi-cell modules (8, 9) stack along the main axis held in place by a frame-like structure (2, 3) between modules and external housing (1). A restrainer protruding from the inner surface of the external housing can be seen in Figure 1 (but having no reference number) holding frame (2) in place. The arrangement allows the fuel cell stack to expand within housing (1) as can be drawn from column 4, last paragraph. The subject-matter of **claims 1-4, 6 and 18** is lacking novelty.

3. Inventive step

The subject-matter of claims 10, 11, 15, 17 and 21 appears not to satisfy the requirements of inventiveness according to Article 33(3) PCT:

3.1 An alternative solution (with respect to springs) of the problem how to apply a uniform pressure on the stack components (as claimed in claim 10) consists in providing coolant plates/passages capable of applying a uniform pressure on stack modules. However,

this feature has already been employed for the same purpose in another fuel cell system, see Figures 3, 5 and 6 and column 12, lines 12-48, of **D5** (US 5824199). It would be obvious to the person skilled in the art, namely when the same result is to be achieved, to apply this feature with corresponding effect, thereby arriving at the subject-matter according to **claim 10**.

3.2 **Claims 11, 15, 17 and 21** are regarded as not being inventive because the technical features claimed therein are either obvious for the skilled person, do not contribute to the solution of the problem to be solved or do not have a surprising technical effect.

4. Industrial applicability

The subject-matter of claims 1-23 satisfies the requirements of industrial applicability according to Article 33(4) PCT.

Re Item VIII

1. Clarity

The following points are unclear, contrary to Article 6 PCT:

1.1 It is unclear in **claim 15** what a cell monitor presser is.

below occurs in which water is produced from oxygen, hydrogen ions and electrons (i.e., the electrons produced on the anode of the adjacent MEA come to the cathode through the separator, or the electrons produced on the anode of the cell disposed at an end in the cell stacking direction come to the cathode of the cell at the opposite end via an external circuit), whereby electricity is generated.

Anode side: $H_2 \rightarrow 2H^+ + 2e^-$

Cathode side: $2H^+ + 2e^- + (1/2)O_2 \rightarrow H_2O$

In a conventional stacking method, modules are retained in the following manner.

A spring 34 is disposed on an end of a cell stack in the cell stacking direction, and a swing portion 35 and an adjusting screw 36 are provided thereat. The modules of the stack 23 are retained with the spring force of the spring 34 providing a constant load in the cell stacking direction, and are retained in directions perpendicular to the cell stacking directions by the friction force of the spring force × the friction coefficient.

In some cases, the modules are restrained from outside the cell stack through the use of an external restrainer member, in order to further reliably retain the modules in directions perpendicular to the cell stacking direction.

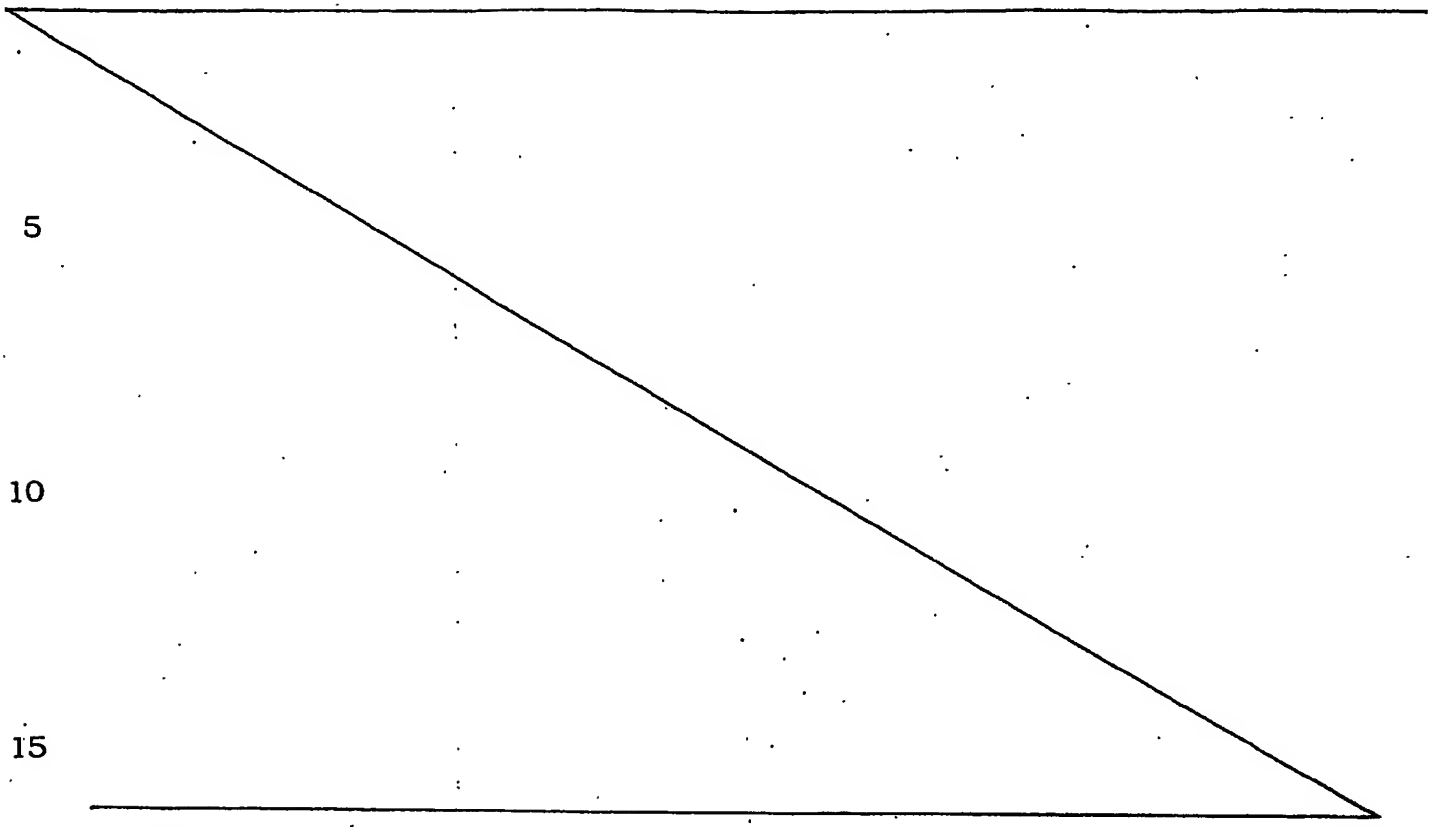
Further, document DE 100 49 801 A1 discloses a fuel cell assembly, wherein fuel cell modules are secured in the stack axis by an elastic holding plate that is coated with an insulating material. A spring applies a uniform pressure on the stack. The so built fuel cell assembly is enclosed within a container to prevent intrusion of impurities into the assembly.

Another fuel cell assembly is disclosed in document DE 195 45 111 A1. This assembly comprises a plurality of fuel cell modules surrounded by an elastic, electrically insulating frame, wherein the modules are housed in an enclosure also having an insulating layer. Elastic members are provided to relieve mechanical movement of the modules due to thermal expansion.

Further, document US 4,176,213 discloses a battery unit, containing one or more fuel-cell blocks, wherein the blocks are attached to a beam having an I-shaped cross section, on both sides against the thin intermediate section thereof.

Document US 5,824,199 A further discloses an electrochemical cell having an inflatable member, wherein a conductive inflatable member is provided between an electrode and a current for providing uniform contact pressure, and thus uniform electrical contact between the electrode and the current bus. The inflatable member comprises a pair of flexible plates, where one plate is thinner than the other.

Further, document JP 09092324 discloses a cell module which is formed of a cell layered product and a module forming member. Each module has a module frame clamping a plurality of single unit cells together, wherein the stacked modules are surrounded by an external enclosure. An insulation layer made from rubber or resin is provided between multi cell modules and an inner wall of a frame as well as between an outer wall of the frame and the enclosure.



[0006] The conventional stacking method has the following problems.

1. When a cell stack having a total mass of M receives an impact of an acceleration α of several gravitational accelerations to about 20 G (G is the gravitational acceleration), a shearing force of Mα/2 occurs near an end portion of the cell stack. If the shearing force becomes greater than the spring force times the friction coefficient, sliding occurs between modules adjacent to the end portion of the cell stack so that the cell stack may disassemble.
2. If modules are retained from outside a cell stack by an external restrainer member, there is a risk of a stack end cell sticking onto the external restrainer member while moving in the cell stacking direction relatively to the external restrainer member as cell constituent members, such as MEAs, diffusion layers, etc., creep due to spring force. Thus, there is a risk of damage to cells. If the spring force is reduced in order to reduce the creep, attainment of a necessary inter-cell contact surface pressure is likely to become impossible.

[0007] A problem to be solved by the invention is that a cell stack disassembles as modules adjacent to an end portion of the stack slide upon an impact of acceleration in a direction perpendicular to the cell stacking direction (first problem).

Another problem to be solved by the invention is the disassembly of a cell stack upon an impact of acceleration in a direction perpendicular to the cell stacking direction combined

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(amended) Claims

1. A fuel cell assembly comprising:
a plurality of multi-cell modules disposed in series;
an external member; and
an external restrainer member,
wherein the multi-cell module has a multi-cell assembly formed by stacking a plurality of cells, and a module frame having a first wall that surrounds the multi-cell assembly and that extends in a cell stacking direction of the multi-cell assembly,
wherein the external member extends outside the plurality of multi-cell modules and in the cell stacking direction along the multi-cell modules, and wherein the external restrainer member is provided between an internal surface of the external member and an external surface of the first wall of the module frame of the multi-cell module.

2. The fuel cell assembly according to claim 1, wherein in the multi-cell module, the multi-cell assembly of the multi-cell module is left unrestrained in the cell stacking direction by the module frame of the multi-cell module so as to relieve thermal expansion of a cell in the cell stacking direction.

3. The fuel cell assembly according to claim 1, wherein in the multi-cell module, cells of the multi-cell assembly are adhered to one another.

4. The fuel cell assembly according to claim 1, wherein in the multi-cell module, a space is formed or a deformable adhesive member is provided between an external surface of the multi-cell assembly of the multi-cell module and an internal surface of the first wall of the module frame of the

multi-cell module so as to relieve thermal expansion of a cell in a direction perpendicular to the cell stacking direction.

5. The fuel cell assembly according to claim 1, wherein the plurality of multi-cell modules are disposed in series in the cell stacking direction, and a spring box is disposed in series in the cell stacking direction with respect to the plurality of multi-cell modules disposed in series, and a spring force of the spring box is applied to the plurality of multi-cell modules in the cell stacking direction.

6. The fuel cell assembly according to claim 1, wherein the module frame has a second wall that extends in a direction perpendicular to the cell stacking direction, in addition to the first wall.

7. The fuel cell assembly according to claim 6, wherein a coolant passage is formed in the second wall.

8. The fuel cell assembly according to claim 7, wherein a contact surface of the second wall which contacts a cell is formed of an electrically conductive material.

9. The fuel cell assembly according to claim 6, wherein at least a portion of a contact surface of the second wall which contacts a cell is formed so as to be displaceable in the cell stacking direction.

10. The fuel cell assembly according to claim 9, wherein a coolant passage is formed in the second wall, and a portion of the second wall which is displaceable in the cell stacking direction is displaced by a pressure of the coolant passage.

11. The fuel cell assembly according to claim 1, wherein an external surface of the module frame and an internal surface of the external member contact each other in a point contact fashion.

12. The fuel cell assembly according to claim 1, wherein the module frame is provided with an opening for mounting, on the multi-cell assembly, a member that electrically connects the multi-cell assembly to an external device.

13. The fuel cell assembly according to claim 1, wherein the module frame includes at least two frame members that are separate from each other.

14. The fuel cell assembly according to claim 1, wherein an internal surface of the module frame has a groove for an adhesive.

15. The fuel cell assembly according to claim 1, wherein the module frame is provided with a cell monitor presser that extends from the module frame toward an external surface of the cell monitor, wherein the cell monitor presser is located near the cell monitor.

16. The fuel cell assembly according to claim 1, wherein at least a portion of the module frame is formed of a non-electrically conductive material.

17. The fuel cell assembly according to claim 1, wherein frame members that constitute the module frame made of a resin are disposed at four corner sites of an end cell of a multi-cell assembly of the multi-cell module.

18. The fuel cell assembly according to claim 1, wherein the module frame is formed of an elastic member.

19. The fuel cell assembly according to claim 18, wherein a friction coefficient of a surface of the elastic member is smaller than a friction coefficient of the elastic member itself.

20. The fuel cell assembly according to claim 18, wherein the module frame is connected to an end cell of a multi-cell assembly of the multi-cell module.

21. The fuel cell assembly according to claim 18, wherein a wire is embedded in the module frame.

22. The fuel cell assembly according to claim 1, wherein the external restrainer member is formed of a deformable material applicable to deform in a direction perpendicular to the cell stacking direction.

23. The fuel cell assembly according to claim 1, wherein the external member is a casing, and wherein the external member also serves as a tension plate.